INNOVATION AND CREATIVITY IN PROCESS CONTROL AND MANUFACTURING

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Short Abstract:

The processes industry and manufacturing are characterized by a variety of algorithmic methodologies and techniques that described their function. therefore the methodology for teaching of Automatic Control of Processes for innovation projects, construct a profile from the student based on validated evidence of the professional comprehensive training solution, defined in learning skills [Tobon, 2005] for the structured approach to the problem of controlling processes and workable solution, aimed applies to integration of management actions functional process controls, integrating threads and systemic response of these.

Key words: process control, finite state machines, innovation in automation, process control protocols, machine control.

1- Comprehensive training

The formation in skills for the innovative development of process control and manufacturing, relies on methodologies of student-centered learning as the axis of the process with social inclusion in leaders environment , it is based on human integrity and to being, knowing and doing [Tobon, 2005] [Shinseiki, Hesselbein, & Bass, 2004]. The social environment, industry motivates the student to identify the processes, that are boarding and solvable problems with ethical responsibility and progressive spirit, for this reason it is important to create of integrated working teams under the discipline, ethical criteria and with technical profile for the project development [Jack, 2009].

The appropriation of knowledge transform the leader in a teachers [Betof, 2009] to give answers and explanations supported with strategic capacity in developing solutions to the proposed problems.

Innovation is an action that requires discipline and a dedicated team with an unbiased approach to learn from experimentation [Govindarajan & Trimble, 2010]. Teamwork is collaborative, finding to resolve the project from different points, but all persons contributing to the same goal, so it is essential to establish performance roles of each team member [Tobon, 2005] according to the aspects of leadership [Jack, 2009]. The meetings socialization of progress evaluation and feedback systems, to continue discussions with the following stages make a democratic and enriching solution. Finally, the solutions have to specifying and perform them skillfully in order to generate a product of higher social service.

2- Learning Methodology

The control problem is now a project of control and born the need required by the industry, supported on a methodology and is developed in the search and construction of solutions problems related to the performance of the processes from technical and technological of knowledge acquired and transmitted by the teacher to the student in the form of creativity and innovation of the proposed solutions to the problems observable in the dynamics of the actions and reactions of varying physical processes, insurable in its implementation.

It might think that learning will occur when comparing between what is expected and what happened [Govindarajan & Trimble, 2010] for this, the methodology finding the construction of the systemic run project, formalized in: Prior knowledge of the process how helps modeling and understanding of the operate, studying of the feasibility of intervention with a plan for evaluating progress, intervention strategy design, formulation of the solution with its implementation, validation and documentation.

3- Control Problem

The control problem search fundamental objective, is to make the process behaves according to the desire required and defined in the process engineering [Smith & Corripio, 1991] or algorithmic manufacturing, validated in the certainty capacity specifying control the complexity and implementation of process controls. From the point of view systemic the problem is reduced to identify the inputs, the environment, history and requirements to meet the output specifications [Ebel, Idler, Prede, & Scholz, 2008].

4- Processes.

The processes in this work are related to industry and manufacturing products material and / or energy, defined on elements of combinatorial logic operation , sequential discrete operation, continuous operation specified or in a protocol under strict and severe language of function specifications of the process, related to the natural concatenation of performance and engineering concepts applied, while a suitable communication system operating of the environment of subsystems synchronizing for achieving comprehensive process. [Murata, 1989]

Logical thinking is the engine spirit that do that processes acquire autonomous performance may have life and properly functioning.

The processes of discrete feature, associate the management usually to a level, operational discontinuous, fractional in the realization of defined activities such as events, enabled by initial conditions and closed the fulfillment of final terms. [Murata, 1989]. These activities are organize in a network of program execution according to the operation of the system in a gant chart (gant) called state machine, structured to achieve the process purpose. These events in the network of performance can be sorted according to their interopertividad: sequential, concurrent, cooperating, deterministic, stochastic or continuous operation.

In the context of plant control is the response of step functions generated from the state machines in a hybrid configuration [Campbell & Wainer, 2006], as command for the threads and/or actuators of nature continuous in his operating range.

The concept of automated factory leads to broader concepts of automation processes, such that the whole is an integrated without topological constraints, multiple specificities of the processes, threads and machine system. This solution is achieved by building a layer of higher level in the hierarchy of control with the same methodology of state machines, using distributed control concepts supported in communication networks for the development of remote real-time.

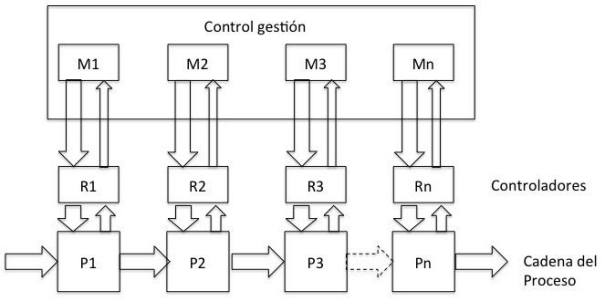

Figure 1: Structure of plant systemic.

5- The given problem

Control methodologies have emerged from the concept of observing the behavior of natural laws that govern the process, then it has developed strategies and actuator devices to intervene these natural behaviors and finally methodologies and control structures are developed, searching that the behavior the process to be governed by the man, for a desired purpose.
In this vein the technological base is plentiful with full capacity to meet any need for a typical industrial process, where actions are dosed mass and / or energy to power the process. The methodology outlined here starts building the solution from industrial processes need to control actuators Shares on integrating systemically related threads in a dedicated management structure in real time to address and manage the complexity of the problem. Finally actuators are those confront the fine adjust bass tune strategies on energy and mass balances on natural responses in processes, in which the concept of sublevels of closed loop control process governing the behavior of system or plant.

6- Finite state machine

The algorithmic solution of this methodology is part of the theory of finite automata called supported the construction of logical networks called Finite State Machines (FSM) known as Finite State Automata (FSA), based on the theory of networks Petri [Murata, 1989], or their derivatives such as Grafcet methodologies that have proven effective for representing such systems.
In a FSM, circles defining actionable events actuators and / or threads that describe the various situations that can happen when the process has produced the conditions of entry into operation represent the states.
The Signals State transitions that are logical expressions [Wang & Cai, 2006] of transient signals whose validation process generates competition triggers movement from one state to another according to the behavior of the process ensured compliance with the conditions [Lavagno, Keutzer, Sangiovanni-Vincentelli & 1991] reactive process by which finite state machines are subjective and depend on each specific problem [Yun & Dill, 1993]. These transitions are represented as a line (arrow) indicating the name of the signal and the transition from one state to another.
The construction of the network transition is ensured in the structure described in the premises of the protocol and executed on the reaction of the sensors or the information of the development of other events according to the systemic structure of the solution to the problem, or validation Calculation of variables or flags synchronization signals, or timing or progress meter. Starting a state will exist depending on the criteria of entry into operation of control, usually the initial state which acts as a starting point is the state of your drive off and walking states transitions validated by winning the competition in the defined network rules of the protocol and the priority management or conflict resolution algorithms.

These transitions can lead to variable assignments associated registering, posting or drop sync flags, setting timers or counters onset or progression of dynamic variables and calculation process. Graphically represented after the logical expression of the transition followed by a slash and then the assignment expression. Deterministic processes in a sequential machine is generated from the activation of the first rule to completion. In stochastic processes is the factor

of randomness that defines the navigation path in the network. In more complex systems these nondeterministic choices involves the application of other proven in artificial intelligence such as fuzzy logic, called Fuzzy State Machine techniques.
The changing levels during different stages of advancement is the implementation of steps on / off or reference values to the system input actuator so it is necessary to observe the consistency of the response of the actuator and the requirement of both FSM time and type of response.
The analysis of a process may result in actions redesign to increase efficiency, reduce costs, improve quality and shorten reducing production times and product delivery or service. The interpretation of the protocol for the development of the FSM can lead to generate different functional solutions with redundant states in which it may be necessary to analyze synthesis that optimizes development. In the same machine two states are equivalent if the machine can start in any of these states and generate the same set of possible sequences of output when any input sequence is provided. This makes the set of control states of a machine can be minimized without changing the external behavior of the machine, replacing any set of equivalent states by a single state.
The abundance of actuators allow a process to characterize it as multiprocessing systems where it is profitable to develop several machines simplest finite state where each plays a smaller number of actuators, hopefully an actuator for each FSM, but also occurs the risk of duplicating FSM redundant efforts.
The distributed under the concept of multitasking operation, nature can expand the solution and control the entire process local or geographically distributed process sections. Takes importance as an essential part of the logistics system of Communications, within the complexity and the environment of performance, both data from the sensors of the system, the actions must decide to actuators and exchange of information and data synchronization on different machines.

7- Continuous controllers

Control history began device level actuating, solving problems of handling or dispensing currents mass or energy in continuous processes and possibly dependent variability systemic configuration. From managing projects with MEF synthesized, these subsystems can be seen as parts of the process actuators. The methodology for the solution of these subsystems is to identify the mathematical model of this thread [Bolton, 2001] [Ogata, 1998], identifying the transfer function by the approach of energy or mass equations balance differential [Smith & Corripio, 1991] [Jack H., 2004] [Kuo, 1996]. About this transfer the function behavior or responses to actions that may be subject to process performance [Bakshi & Bakshi, 2008] is identified. Obviously these answers are not the most ideal in execution behavior and it is therefore necessary to have items such as PID controllers to adjust the regulatory response to the desire of the best operating system [Cooper, 2004]

.8- Aplicación

The above theory is illustrated with an example classic and basic of control implementation on a hot water tank. See Figure 2. The text of approach of the problem by the Process Engineer can be summarized in the following premise: You want to build a tub under atmospheric pressure, to heat water to a temperature between a minimum and maximum value, you must also ensure a minimum supply hot water.

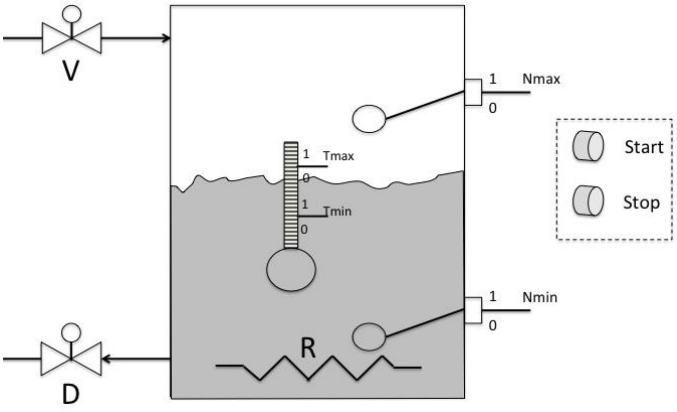

Figure 2: Tank level and heating.

The protocol adjusted writing will be on the following premises. It has a hot water tank to which it will control its water level between Nmin and Nmax value by opening or closing a valve V to supply the liquid.
The internal temperature was adjusted between Tmin and Tmax value through an electrical resistance R, which is connected to heat and disconnects when the maximum temperature has been reached.
For safety the resistor must be disconnected when the water level is below the minimum value.
The hot water tank has a starter button Start and a Stop off in your control.
To approach the problem solution, which in some cases can be difficult to understand because of the systemic complexity of the problem a flowchart of data which allows a zoom separate subsystems and solutions are developed. This diagram identifies the part of the actuators of the process, in this case the fill valve and endurance. In the first instance each actuator is assigned its respective control, level control valve and temperature control for resistance, then according to the assumptions of the protocol sensors with respective controls relate. The following graph illustrates the data flow diagram of the problem of the boiler

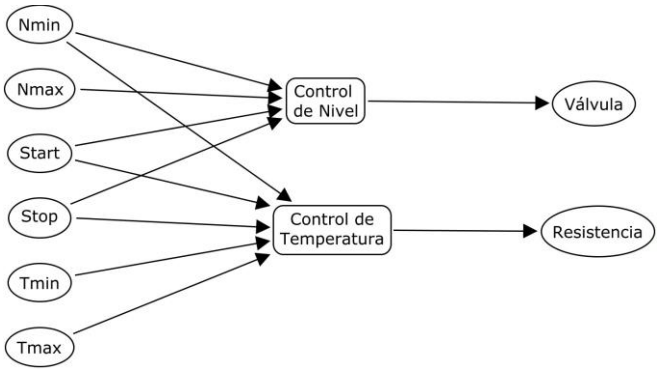

Figure 3: Data streams.

A panoramic observation allow appreciate that in this process is necessary two functional modules that correspond to level control that acting on the valve and temperature control acting on the resistance, where Nmin and Nmax are specific sensors for the level control and Tmin is required and Tmax are specific sensors for the temperature control. The relationship of these controls is given by the sign of Nmin which is also used for controlling temperature due to the premise of safety.The Start and Stop signs are generic signals for the two controls.

With these features and according to performance specified protocol on the premises is developed the control engineering solution about the concept of finite state machines.

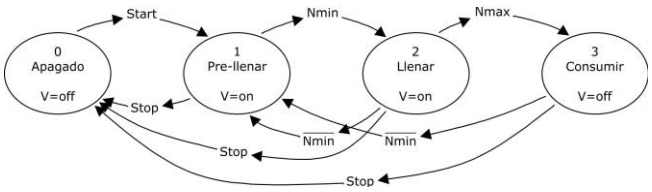

Figure 4: MEF level control.

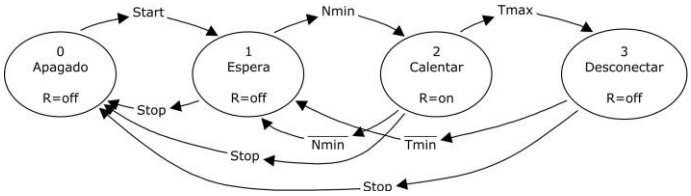

Figure 5: MEF temperature control.

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